

THE HATCHING MUSCLE IN FRANKLIN'S GULL

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AT present the hatching muscle is known in chickens (Keibel, 1912; Pohlman, 1919; Fisher, 1958) and in North American grebes (Fisher, 1961). It is desirable, then, to record its occurrence and development in additional species.

This pair of muscles, *M. complexus* or, preferably, the caput portion of *M. cucullaris*, originates on the dorsal lateral surface of the anterior part of the neck and inserts on the back of the skull. It is thus in an excellent position to raise the head and bill. Although the muscle functions throughout the post-natal life of the bird, it is thought that its most critical function is to raise the egg-tooth against the shell to produce the "pip" in the shell that is the first outward manifestation of hatching. Reference may be made to Fisher (1958) for a discussion of this function.

Our interest here is to present the grosser features of the morphological development of this muscle in Franklin's Gull (*Larus pipixcan*).

MATERIALS AND METHODS

Eggs and young birds were taken from one of the several gull colonies in the Delta marshes at the south end of Lake Manitoba, Canada. The specimens included: 127 eggs, eight young birds from the nest, and two adult Franklin's Gulls; six eggs of the Common Tern (*Sterna hirundo*); and four eggs of the Black Tern (*Chlidonias niger*).

All eggs of the gulls were collected one day; one-fourth of them were sampled immediately and the remainder incubated at 99.5 F and approximately 60-70 per cent relative humidity. Samples of the incubated eggs were taken daily. When the first gull eggs pipped, the embryos had great difficulty in emerging; some eggs were pipped for three days before the chicks came out, and some died in the egg. The difficulty seemed to lie in low humidity. Therefore, additional trays of water were placed beneath the eggs, with the top of the water about an inch below the bottom of the eggs, or some two inches closer to the eggs than formerly. Thereafter, chicks emerged within 24 hours of pipping.

Although it was possible to keep young gulls alive at least as long as 14 days on a diet of turkey "pre-starter" food, it was felt that their growth was probably not normal. Therefore, data on birds maintained longer than two days after hatching were not included.

Since the age of the embryo could not be determined accurately, body weight was used as the criterion for the stage of development. The data on body weight, particularly those of embryos just before and just after hatching,

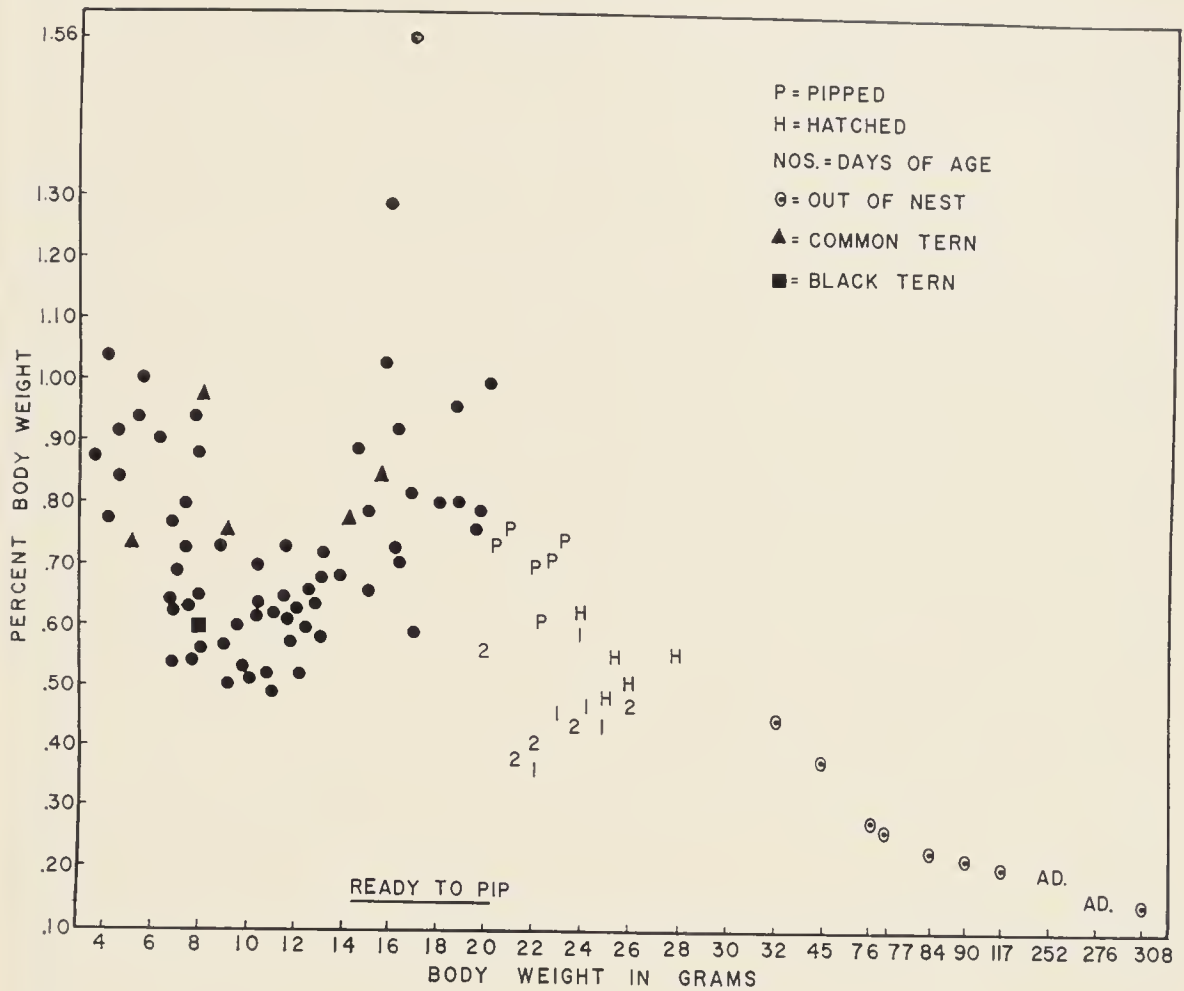


FIG. 1. The development of the hatching muscle in Franklin's Gull as indicated by ratios of muscle weight to total body weight. A few specimens of Common Terns and Black Terns are included.

must be viewed with caution. Yolk was drawn from the bodies of embryos near hatching; this was necessary to insure uniformity in weights of true body tissues because at this stage varying quantities of yolk remained externally in the yolk sac. Thus, body weights of "pipped" embryos appear to be less in Fig. 1 than do weights of "hatched" embryos; probably these weights should be nearly the same, aside from individual variation.

When the embryo was taken from the shell the extra-embryonic membranes were cut away, and it was gently blotted several times on newspaper to remove surface moisture, before being weighed to the nearest tenth of a gram. The hatching muscles were easily excised with iridectomy scissors and weighed in milligrams on a Roller-Smith Precision Balance. Removal and weighing took less than a minute, once the muscle was exposed; thus undue desiccation did not occur.

RESULTS

In Franklin's Gull and the two terns the basic morphological pattern of the

hatching muscle was the same as in the chicken and grebes previously described. Differences in structure and in development between the species were primarily related to differences in body size and in length of incubation period.

Three segments were most frequently found (78 birds), but eight birds had four segments in the muscle. The posterior segment of the three was always smallest, sometimes extremely so. When a fourth segment was present it was the smallest. In one Common Tern the large first segment was partly divided into two segments by transverse raphae extending medially from the lateral edges of the first segments. Segmentation in the definitive muscle was not visible, even faintly, until the 7-gram stage and remained faint until the 9- or 10-gram stage. In specimens of 10 grams to 16 or 18 grams in body weight the segments were obvious. At this later stage the segmentation began to be obliterated; in approximately 50 per cent of the specimens no segments were visible just before hatching. Immediately after hatching the segments were faintly discernible and they remained so in the adult.

Another feature showing change during development was the extent of medial contact between the muscles of the two sides. This contact was not found in embryos weighing less than 5 grams. At the 7- to 10-gram stage the muscles were touching each other in the anterior one-third to one-half of their lengths; in other words, the first segments and parts or all of the second segments were in contact. From 11 to 20 grams the medial juxtaposition involved the first two pairs of segments. In the "pip" stage (20-23 grams) there was nearly total contact throughout the length of the muscle, and this was maintained until about the 30-gram stage. Thereafter the posterior ends of the muscles appeared to separate: actually, the medial portions regressed and the lateral edges maintained their positions. This "separation" progressed until less than the anterior third of the length was in contact in the adult gulls.

At the 4-gram stage the hatching muscle weighed approximately 0.035 gram. There was a straight-line, gradual increase to 0.080 gram at a body weight of 13 grams. At this later stage there was a strong upsurge in absolute weight of the muscle, that sometimes reached 0.260 gram at 17 grams of body weight, but was usually about 0.170 gram. Muscle weights declined during pipping (0.16 gram), hatching (0.13), and the first two post-natal days (0.10). There was a slow increase in the muscle weight of the chick in the nest; at 70 to 90 grams of body weight the muscle weighed approximately 0.19 gram or only slightly more than at the pre-pip stage. In adults, the muscle weight of approximately 0.40 gram was only slightly more than twice the muscle weight of the newly hatched chicks: body weight in this same period increased more than 10 times.

In Fig. 1 are plotted the quantitative changes in the muscle, as compared

to body weight. It may be noted that there were two peaks of development—the first as the embryo began to develop and the second at the “ready-to-pip” stage. The first was the result of the early cephalic development typical of all embryos; the relative recession between the peaks, reaching a low at 10 to 12 grams, was more than compensated for by the later, progressive, caudad development of the young gull.

The most significant change in relative size occurred at the pre-pip stage, when muscle weights were as much as 1.5 per cent of body weight, or some three times as much, relatively, as at the 10-gram stage. During the pipping process the muscle became considerably smaller, and it was still smaller after hatching. Muscle size continued to decline gradually, until in the adult it was only 10 per cent of the relative size it was just before pipping and only 15 per cent of the relative size attained at the 4-gram stage.

The few examples of the Common Tern seemed to indicate a similar prenatal history for the hatching muscle, and the one Black Tern embryo was not inconsistent.

Changes in color of the muscle were apparent; it was thought that these were related to the infiltration of lymph. The lymph color first appeared in the anterior pair of segments, in some specimens, at the 8-gram stage of body weight. It is recognized that the color of lymph is variable, perhaps depending upon the source of the lymph, but in these studies whitish-yellow to yellow were the colors we associated with a supposed increased lymph content. This color was frequent in 10-gram specimens and consistently appeared in 12-gram embryos in which the color occasionally was found in the second pair of segments. All segments were lymph-colored by the 14-gram stage, and the infiltration in some individuals was sufficient to produce noticeable swelling. The infiltration and consequent swelling were frequent in specimens weighing 16 to 18 grams. At 19 grams and continuing through the pipping phase, the muscles of all embryos were filled with lymph.

In general, the development and regression of the lymph nodes, lying on either side of the pair of hatching muscles, followed the chronology of these muscles. The nodes were first visible as one or more granules on either side; by the 10-gram stage the nodes had started to elongate. The elongation proceeded much more rapidly than the increase in width and reached its maximum just after hatching. These increases were in the order of 20 times for length and 2 times for width. After the second day, nodular length was sharply decreased, but width increased to as much as 4 times the width at the 6-gram stage. These lymph nodes were not found in a non-flying young (308 grams), out of the nest, or in two adults.

The measurements (Table 1) of these nodes do not give an accurate portrayal of the mass of the lymph tissue present or, of course, of the activity

TABLE 1
AVERAGE MEASUREMENTS (MM) OF LYMPH NODES OF FRANKLIN'S GULL¹

Body Weight or Stage	Left Side	Right Side
less than 5.0 grams	one or two granules or absent	
6-7	1.5 × 1.7	1.7 × 0.5
7-8	1.9 × 1.5	1.4 × 1.6
8-9	1.5 × 0.7	1.7 × 1.7
9-10	2.3 × 1.0	2.0 × 0.7
10-11	4.3 × 1.7	3.7 × 1.9
11-12	6.5 × 2.2	5.2 × 2.7
12-13	5.8 × 1.8	4.6 × 2.8
13-14	6.8 × 1.8	5.5 × 2.8
15-16	10.4 × 2.8	7.2 × 3.1
16-17	10.0 × 2.7	7.5 × 2.8
18-19	9.3 × 3.3	8.3 × 3.3
19-20	9.0 × 2.0	8.5 × 2.5
early pip	29.8 × 2.1	27.5 × 2.3
just hatched	26.4 × 2.4	29.6 × 2.0
one day of age	29.6 × 2.2	26.6 × 2.0
two days of age	27.4 × 1.8	23.6 × 1.1
32 grams	2.0 × 2.0	7.0 × 3.0
45	4.0 × 2.0	few granules
76	16.3 × 4.1	12.6 × 1.1
77	4.1 × 4.3	6.2 × 3.1
84	2.7 × 3.3	6.4 × 5.4
90	12.3 × 7.7	12.1 × 5.2
117	10.6 × 7.3	12.0 × 3.6
308	not found	not found
adult	not found	not found

¹Numbers of specimens may be obtained from Fig. 1.

of the nodes. They do give, however, a rough index. The difficulty is that the nodes in their early and late stages often consisted of scattered granules or separated lobes, and the measurements simply indicated the overall, maximum *area* occupied by these lobes or granules. From the 13-gram stage to the "pre-pip" stage (about 20 grams) the nodes were a fairly homogeneous, solid mass of tissue. During pipping this mass became differentiated as an elongated continuous string of beads. At hatching some beads were missing from the string and, by the second day after hatching, many beads were gone.

Some incidental observations on the lymph nodes included: (1) the node on the right was larger in 27 birds, while the left node was larger in 47 instances; and (2) no node was found on the right side in five birds and none on the left in four birds.

General miscellaneous observations included: (1) Franklin's Gulls hatched

at 24 to 28 grams of body weight, Common Terns at 14 grams; (2) humidity was an important factor in hatchability in the gull—relative humidities of nearly 90 per cent seemed best; (3) only three of 110 gull eggs were infertile; and (4) there was an obviously increased fragility of the shell as hatching approached.

DISCUSSION AND SUMMARY

The general conformation of the hatching muscle and its topographical relationships in Franklin's Gull are the same as in chickens and in North American grebes. It is a paired muscle of three (sometimes four) segments arising from the anterior part of the dorsal cervical region and inserting on the posterior dorsal part of the skull.

In the beginning the members of this pair of muscles are rather widely separated. Gradually, medial contact is established, anteriorly at first. The contact proceeds posteriorly until, just before hatching, the muscles are touching in nearly all their length. Slowly the contact decreases, beginning posteriorly, until in the adult only a portion of the inner edges of the members of the first pair of segments touch each other.

As in the other species, the muscle of the gull is largest just before pipping. However, there are species differences in the relative magnitude at this time: chick, 1.9 per cent of body weight; grebes, 0.7 per cent; and gull, 0.9 per cent. The close similarity between grebes and gulls may be related to similarities in structure, strength and moisture of the shell, as discussed by Fisher (1961). The decline in size of the muscle in the first two days after hatching is slight in grebes, from 0.6 per cent of body weight to 0.4 per cent in the gull, and from 1.9 to 1.0 per cent in the chick. The resurgence of the muscle prior to pipping, that is, the increase from the prenatal low, is nearly a five-fold increase in relative weight in the chick, three times in the gull, and less than twice in grebes.

Other manifestations accompanying the rapid development of weight of the muscle prior to hatching include increased lymph coloration of the muscle, which culminates in the muscle and surrounding tissues becoming lymph-filled. The muscle becomes turgid, so much so that the segments appear swollen and the raphae between segments appear as tight, constricting bands. Indeed, the raphae are virtually covered.

In the gull and chick, it is thought that the lymph comes from the lymph node lateral to each muscle. The development and the regression of the nodes parallel these features of the muscle. However, the nodes are much larger in the gull than in the chick, despite the lesser body weight of the gull. In grebes, at most only a few lymph granules are present in the above-described position. Any explanation for the rapid decrease in the size and the eventual disappearance of these nodes must await histological examination to ascertain their

nature, and biochemical studies to determine the materials produced. It is possible that these nodes are of mixed function.

ACKNOWLEDGMENTS

Sincere thanks go to my wife, Mildred, and to my son, James, for considerable aid in the collecting of eggs and birds and in making measurements in the laboratory. I wish to express my appreciation to Mr. Albert Hochbaum, Director, Delta Waterfowl Research Station, for the use of the facilities there, and to the Graduate School of Southern Illinois University and to the Wildlife Management Institute for funds.

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ILLINOIS. 20 JANUARY 1961

NEW LIFE MEMBER



Harriet Bergtold Woolfenden, of Ipperwash Beach, Forest, Ontario, Canada (formerly of Dearborn, Michigan), an active member of the Society since 1951, has now become a new Life Member. Mrs. Woolfenden, a graduate of Smith College, is very active in the Detroit and Michigan Audubon Societies, having been a member of both boards of directors. She is a member also of the AOU, Wilderness Society, National Parks Association, and the Federation of Ontario Naturalists. Her four privately printed books of poetry contain "nothing ornithological," but her chief interest is field bird study and the sharing of her experiences with others; and her poems reflect a keen awareness of natural phenomena and a compatibility with them.